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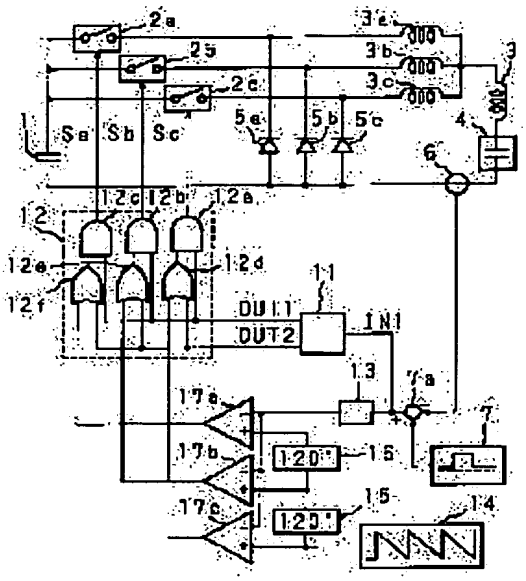
(54) POWER CIRCUIT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a power circuit wherein the rising and falling of its output current which varies stepwise are fast and ripples on the output current is small.
SOLUTION: This power circuit is provided with a D.C. power supply ore capacitor 1, multiple series circuits which are connected in parallel with one another comprising switch circuits 2a-2c and reactors 3a-3c, and constitute loop circuits including the D.C. power supply or capacitor 1 and a load 4, multiple free-wheel diodes 5a-5c connected in parallel with the load 4 and the reactors 3a-3c, respectively, a current detector 6 for detecting the current flowing through the load 4, a deviation imputing unit 7a for computing the deviation of the current value detected by the current detector 6 from a given control directing value, and on/off control means 11, 12, 13, 17a-17c for controlling the turning-on/off of the switch circuits 2a-2c and for simultaneously controlling the turning-on or the turning-off of the switch circuits 2a-2c, based on the deviation value computed by the deviation computing unit 7a.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The series circuit connected to two or more juxtaposition which consists of the switching circuit and rear KUKUTORU which should make a loop-formation circuit including DC power supply or a capacitor, these DC power supply or a capacitor, and a load, Two or more free wheel diodes which should be connected to juxtaposition at said load and rear KUKUTORU, respectively, The current detector which detects the current which flows for said load, and the deflection computing element which calculates the deflection of the given control-command value and the current value which this current detector detected, Said switching circuit is turned on/off controlled based on the deflection which this deflection computing element calculated. The power circuit characterized by having made that increase and decrease of the current which is equipped with the ON / off control means which controls [ON-] or controls [off-] said switching circuit instantaneous based on said deflection, and is passed for said load of control should be carried out at the shape of a step.
[Claim 2] ON / off control means has a judgment means to judge the size of the deflection which the deflection computing element calculated, and when it judges with it being within the limits of predetermined [means / this / judgment] in said deflection It is the power circuit according to claim 1 which is the same period from which a phase differs mutually, turns on/controls [off] a switching circuit according to said deflection, and controls [ON-] or controls [off-] said switching circuit instantaneous when it judges with said deflection having said judgment means out of range [predetermined].
[Claim 3] The integration operator machine which integrates with the deflection to which the deflection computing element calculated ON / off control means, The adder which adds the multiplication signal in which the proportionality computing element which carries out the multiplication of the predetermined gain to said deflection, and the integral signal with which said integration operator machine integrated and said proportionality computing element carried out multiplication, and is outputted as a control signal, The triangular wave signal output machine which outputs the triangular wave signal or saw-tooth-wave signal of a predetermined period, The power circuit according to claim 1 which has the comparator which compares the signal which this triangular wave signal output machine outputted with the control signal which said adder outputted, and the ON / off control circuit which turns on/controls [off] a switching circuit according to the comparison result of this comparator.
[Claim 4] When it judges with a judgment means to judge the size of the multiplication signal with which the proportionality computing element carried out the multiplication of ON / the off control means, and this judgment means of this multiplication signal being larger than the 1st predetermined value When a 1st set point output means to output the 1st set point set up beforehand as a control signal, and said judgment means judge with said multiplication signal being smaller than the 2nd predetermined value smaller than the 1st predetermined value It is the power circuit according to claim 3 which is further equipped with a 2nd set point output means to output the 2nd set point set up beforehand as a control signal, and compares the signal with which the triangular wave signal output machine outputted the comparator with the control signal which the 1st or 2nd set point output means outputted.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the power circuit to which electric power is supplied to an arc lamp or a flash lamp for exciting an YAG laser etc.
[0002]
[Description of the Prior Art] Drawing 8 is the block diagram showing the configuration of the conventional power circuit indicated by JP,5-211765,A. The forward side edge child of a capacitor 1 is connected to one terminal of a switching circuit 2, and, as for this power circuit, the other-end child of a switching circuit 2 is connected with one terminal of a reactor 3 as the cathode of a free wheel diode 5. The other-end child of a reactor 3 is connected to one terminal of the lamp 4 which is a load, and the other-end child of a lamp 4 is connected to the anode of diode 5, and the negative side terminal of a capacitor 1 through the current detector 6 which detects the current which flows on a lamp 4.
[0003] The current value which the current detector 6 detected is given to the inversed input terminal of a comparator 8, and the current command value of the current command generator 7 is given to the non-inversed input terminal of a comparator 8. The output terminal of a comparator 8 is connected to D input terminal of a flip-flop 10, and a reference clock is given to T input terminal of a flip-flop 10 from the clock circuit 9. Q output terminal of a flip-flop 10 is connected to ON / off control terminal of a switching circuit 2.
[0004] Below, it explains, referring to the timing chart of drawing 9 which shows it for actuation of such a power circuit of a configuration. Held, after being set to H level synchronizing with the standup of a reference clock shown in (c) as the output signal of a comparator 8 serves as H level and Q output signal of a flip-flop 10 is shown in (b) when smaller than the current command value of the current command generator 7 as the detection current value of the current detector 6 shows (a), a switching circuit 2 will be in an ON state.
[0005] Held on the other hand, after being set to L level synchronizing with the standup of a reference clock shown in (c) as the output signal of a comparator 8 serves as L level and Q output signal of a flip-flop 10 is shown in (b) when larger than the current command value of the current command generator 7 as the detection current value of the current detector 6 shows (a), a switching circuit 2 will be in an OFF state.
[0006] When a switching circuit 2 is ON, the loop-formation circuit which consists of a capacitor 1, a switching circuit 2, a reactor 3, and a lamp 4 is closed. At this time, diode 5 serves as a reverse bias and is an OFF state. If the internal resistance of a lamp 4 is small, a capacitor 1 will continue increasing the current (detection current of = current detector 6 (a)) which discharges when the above-mentioned loop-formation circuit closes, and flows on a lamp 4 according to the time constant of a loop-formation circuit. On the other hand, since the current which opens the above-mentioned loop-formation circuit and flows to a reactor 3 decreases when a switching circuit 2 is OFF, induced electromotive force arises in a reactor 3 in the direction which negates the reduction, and the current of the forward direction of diode flows in the loop-formation circuit of a reactor 3, a lamp 4, and diode 5. This current continues decreasing according to the time constant of this loop-formation circuit.
[0007] To be shown in (a), the current command value of the current command generator 7 changes in the shape of a step, and the detection current of the current detector 6 is controlled with a ripple according to the change. A ripple produces ON / off actuation of a switching circuit 2 with a comparator 8 and a flip-flop 10, and repeats increase and decrease focusing on the current command value of the current command generator 7. If the inductance value of a reactor 3 is set to E, the rate of change of the current (lamp current) which flows on a

lamp 4 is proportional to the value of (E-IR)/L in R and the both-ends electrical potential difference of a capacitor 1 about the resistance of L and a lamp 4 at the time of an increment, and proportional to the value of R/L, respectively at the time of reduction. That is, the rate of change of a lamp current becomes large, so that the inductance in a circuit is small.
[0008]
[Problem(s) to be Solved by the Invention] It was difficult to reconcile the reduction in the ripple of a lamp current, and compaction of the build up time of a current, and falling time amount in the conventional power circuit. That is, although what is necessary is to enlarge the inductance of a reactor 3 and just to lower current rate of change to make the ripple of a lamp current small, the build up time and falling time amount of a current increase.
[0009] Although it is possible to raise a clock frequency and to make [many] the count of switching of a switching circuit 2 as an option, it has the high-speed engine performance in a switching circuit 2, and what has small switching loss is needed for it. However, when the power consumption of a lamp is large, it is difficult to make switching loss small, and there is a limitation also in making [many] the count of switching.
[0010] It is necessary to enlarge current rate of change by lowering the inductance value L of a reactor 3, or raising the charge electrical potential difference of a capacitor 1 to, accelerate the standup of a lamp current, and the response of falling on the other hand to the current command value of the current command generator 7 which changes in the shape of a step. However, since a ripple became large, the inductance value L of a reactor 3 cannot be made small, for example, the build up time and falling time amount of a lamp current could not be disregarded but there was a problem which cannot acquire effective current actual value to a lamp to acquire the current of the short pulse width for several ms.
[0011] Moreover, when a ripple was enlarged, there was a possibility of having promoted degradation of a lamp and having a bad influence on a life, and there was a problem also in respect of maintenance of a lamp. This invention is made in view of a situation which was mentioned above, and the standup and falling of the output current which change in the shape of a step are quick, and it aims at the ripple of the output current offering a small power circuit.
[0012]
[Means for Solving the Problem] The series circuit connected to two or more juxtaposition which the power circuit concerning the 1st invention becomes from the switching circuit and rear KUKUTORU which should make a loop-formation circuit including DC power supply or a capacitor, these DC power supply or a capacitor, and a load, Two or more free wheel diodes which should be connected to juxtaposition at said load and rear KUKUTORU, respectively, The current detector which detects the current which flows for said load, and the deflection computing element which calculates the deflection of the given control-command value and the current value which this current detector detected, Said switching circuit is turned on/off controlled based on the deflection which this deflection computing element calculated. Based on said deflection, it has the ON / off control means which controls [ON-] or controls [off-] said switching circuit instantaneous, and is characterized by having made that increase and decrease of the current passed for said load of control should be carried out at the shape of a step.
[0013] The power circuit concerning the 2nd invention ON / off control means When it judges with having a judgment means to judge the size of the deflection which the deflection computing element calculated, and said deflection having this judgment means within the limits of predetermined According to said deflection, are the same period from which a phase differs mutually, and a switching circuit is turned on/off controlled, and when it judges with said deflection having said judgment means out of range [predetermined], it is characterized by ON-controlling or off controlling said switching circuit instantaneous.
[0014] The power circuit concerning the 3rd invention ON / off control means The integration operator machine which integrates with the deflection which the deflection computing element calculated, and the proportionality computing element which carries out the multiplication of the predetermined gain to said deflection, The adder which adds the multiplication signal in which said proportionality computing element carried out multiplication to the integral signal with which said integration operator machine integrated, and is outputted as a control signal, The triangular wave signal output machine which outputs the triangular wave signal or saw-tooth-wave signal of a predetermined period, It is characterized by having the comparator which compares the signal which this triangular wave signal output machine outputted with the control signal which said adder outputted, and the

ON / off control circuit which turns on/controls [off] a switching circuit according to the comparison result of this comparator.
[0015] The power circuit concerning the 4th invention ON / off control means When it judges with a judgment means to judge the size of the multiplication signal in which the proportionality computing element carried out multiplication, and this judgment means of this multiplication signal being larger than the 1st predetermined value When a 1st set point output means to output the 1st set point set up beforehand as a control signal, and said judgment means judge with said multiplication signal being smaller than the 2nd predetermined value smaller than the 1st predetermined value It has further a 2nd set point output means to output the 2nd set point set up beforehand as a control signal, and a comparator is characterized by comparing the signal which the triangular wave signal output machine outputted with the control signal which the 1st or 2nd set point output means outputted.
[0016]
[Embodiment of the Invention] Below, the gestalt of operation of this invention is explained based on the drawing in which it is shown.
Gestalt 1. drawing 1 of operation is the block diagram showing the configuration of the gestalt of operation of the power circuit concerning the 1st and 2 invention. The parallel circuit where this power circuit consists of the series circuit of switching circuit 2a and reactor 3a, a series circuit of switching circuit 2b and reactor 3b, and a series circuit of switching circuit 2c and reactor 3c is connected between the forward side edge child of a capacitor 1, and one terminal of a reactor 3. The other-end child of a reactor 3 is connected to one terminal of the lamp 4 which is a load, and the other-end child of a lamp 4 is connected to the negative side terminal of a capacitor 1 through the current detector 6 which detects the current which flows on a lamp 4.
[0017] The cathode of free wheel diode 5a is connected at the node of switching circuit 2a and reactor 3a, and the anode is connected to the negative side terminal of a capacitor 1. The cathode of free wheel diode 5b is connected at the node of switching circuit 2b and reactor 3b, and the anode is connected to the negative side terminal of a capacitor 1. The cathode of free wheel diode 5c is connected at the node of switching circuit 2c and reactor 3c, and the anode is connected to the negative side terminal of a capacitor 1.
[0018] The current value which the current detector 6 detected is given to deflection computing-element 7a, and deflection computing-element 7a calculates the deflection (system deviation) of the current command value given from the current command generator 7, and the current value which the current detector 6 detected, and gives the calculated system deviation to the system deviation judging machine 11 (ON / off control means) and a controller 13 (ON / off control means). The output terminal OUT1 of the system deviation judging machine 11 (level judging machine) is connected to the input terminal of one way each of AND circuits 12a, 12b, and 12c, an output terminal OUT2 is connected to the input terminal of one OR circuits [12d, 12e, and 12f] way each, and 12d of OR circuits, 12fe, and a 12f output terminal are connected to the input terminal of another side of AND circuits 12a, 12b, and 12c, respectively.
[0019] The output terminal of a controller 13 is connected to each inversed input terminal of Comparators 17a, 17b, and 17c (ON / off control means), and the saw-tooth-wave signal which the saw tooth generator 14 (ON / off control means) generated is given to the non-inversed input terminal of comparator 17c. The saw-tooth-wave signal delayed from the saw-tooth-wave signal which the saw tooth generator 14 (saw-tooth wave generator) generated by the phase conversion circuit 15 (ON / off control means) 120 degrees is given to the non-inversed input terminal of comparator 17b, and the saw-tooth-wave signal with which the phase conversion circuit 16 (ON / off control means) delayed 120 more degrees of saw-tooth-wave signals which the phase conversion circuit 15 delayed 120 degrees is given to the non-inversed input terminal of comparator 17a. The output terminal of Comparators 17a, 17b, and 17c is connected to the input terminal of another side of AND circuits 12c, 12b, and 12a, respectively, and AND circuits 12c and 12b and 12a output terminal are connected to switching circuit 2a, 2b, and ON / off control terminal of 2c, respectively.
[0020] Below, actuation of the power circuit of such a configuration is explained. When switching circuit 2a is ON, the loop-formation circuit which consists of a capacitor 1, switching circuit 2a, reactor 3a, a reactor 3, and a lamp 4 is closed. At this time, diode 5a (free wheel diode) becomes a reverse bias, and is an OFF state. If the internal resistance of a lamp 4 is small, a capacitor 1 will continue increasing the current which discharges when the above-mentioned loop-formation circuit closes, and flows on a lamp 4 according to the time constant of a loop-formation circuit.

[0021] On the other hand, since the current which opens the above-mentioned loop-formation circuit and flows to reactors 3a and 3 decreases when switching circuit 2a is OFF, induced electromotive force arises in reactors 3a and 3 in the direction which negates the reduction, and the current of the forward direction of diode 5a flows in the loop-formation circuit of reactors 3a and 3, a lamp 4, and diode 5a. This current continues decreasing according to the time constant of this loop-formation circuit by making into initial value the current value which was flowing when switching circuit 2a turned off. Actuation of the capacitor 1 mentioned above, switching circuit 2a, reactors 3a and 3, a lamp 4, and diode 5a is the same also at the case of the case of a capacitor 1, switching circuit 2b, reactors 3b and 3, a lamp 4, and diode 5b and a capacitor 1, switching circuit 2c, reactors 3c and 3, a lamp 4, and diode 5c.
[0022] Switching circuit 2a, 2b, and 2c operate as a polyphase multiplex chopper circuit by performing each its ON / off actuation with a phase which is the same period and is equally different mutually. In a polyphase multiplex chopper circuit, it is common knowledge that a current ripple becomes small in inverse proportion to the square of a source resultant pulse number as compared with the single phase chopper circuit explained by the Prior art. With the gestalt of this operation, since the phase of each ON / off actuation of switching circuit 2a, 2b, and 2c is 120-degree difference three phase circuit mutually, a current ripple is set to one ninth and the fine current control of it with a small current ripple is attained.
[0023] Drawing 2 is a timing chart which shows the actuation in the case of being a direct current wave with the large current command value from the current command generator 7 of the current control circuit of the gestalt of this operation. When a current command value is large, switching circuit 2a, 2b, and each ON time amount of 2c become long. Drawing 3 is a timing chart which shows the actuation in the case of being a direct current wave with the small current command value from the current command generator 7 of the current control circuit of the gestalt of this operation. When a current command value is small, switching circuit 2a, 2b, and each ON time amount of 2c become short.
[0024] For the system deviation judging machine 11, the value which deducted the current value which the current detector 6 detected from the current command value which the inputted system deviation IN1 7, i.e., a current command generator, outputted is judgment level. - When smaller than dV, let the output signal from output terminals OUT1 and OUT2 be L level. For the system deviation judging machine 11, system deviation IN1 value is judgment level. - It is larger than dV, and when smaller than judgment level +dV, let H level and the output signal from an output terminal OUT2 be L level for the output signal from an output terminal OUT1. The system deviation judging machine 11 makes H level the output signal from output terminals OUT1 and OUT2, when system deviation IN1 value is larger than judgment level +dV.
[0025] Drawing 4 is a timing chart which shows actuation of the current control circuit of the gestalt of this operation. Below, actuation of this current control circuit is explained, referring to this timing chart. As it is a flat wave in the small current value I1 or the high current value I2, and the current command value which the current command generator 7 outputted shows (a) and it is shown in (b) when control of the current which flows on a lamp 4 is stabilized and being followed If system deviation IN1 has fallen within the range of judgment level**dV of the system deviation judging machine 11, H level (g) and the output signal from an output terminal OUT2 of the output signal from an output terminal OUT1 are L level (f).
[0026] At this time, the logical circuit 12 (ON / off control means) which consists of AND circuits 12a-12c and OR circuits 12d-12f tells each output signal of Comparators 17a, 17b, and 17c to switching circuit 2a, 2b, and each ON / off control terminal of 2c as it is (((c) d) e). If each inductance at this time 3, 3a-3c, for example, reactors, is made into L/3, the ripple of a current which flows on a lamp 4 will become about about 1 in the case of the conventional example / 3. System deviation IN1 is also given to a controller 13, and a controller 13 gives the output signal set up so that it may become so small that the given system deviation IN1 is large to each inversed input terminal of Comparators 17a, 17b, and 17c.
[0027] Comparators 17a, 17b, and 17c compare the size of the output signal of the given controller 13, and the saw tooth wave which has the positive/negative amplitude which was given from a saw tooth generator 14 or the phase conversion circuits 15 and 16, and from which 120 degrees of phases differ mutually, and give the output signal according to the comparison result to OR circuits 12d, 12e, and 12f. The period used as H level becomes long, so that system deviation IN1 is large, and the output signal of Comparators 17a, 17b, and 17c is less than the period of a saw tooth wave.
[0028] As shown in (a), when the current command value which the current command generator 7 outputted

changes from the small current value I1 to the high current value I2, maximum is set to (I2-I1) and system deviation IN1 exceeds judgment level +dV of the system deviation judging machine 11 (b). In the output signal from the output terminal OUT1 of the system deviation judging machine 11, H level (g) and the output signal from an output terminal OUT2 serve as H level then (f).

[0029] At this time, with regards to the output signal of Comparators 17a, 17b, and 17c, there is nothing, each output of a logical circuit 12 serves as H level, and all of switching circuit 2a, 2b, and 2c become ON. For the reason, in all the paths of a capacitor 1, switching circuit 2c, reactors 3c and 3, and a lamp 4, discharge of a capacitor 1 is performed in the path of the path of a capacitor 1, switching circuit 2a, reactors 3a and 3, and a lamp 4, a capacitor 1, switching circuit 2b, reactors 3b and 3, and a lamp 4, and a list.

[0030] Since it will discharge on a lamp 4 from a capacitor 1 through the inductance of 4L/9 equivalent when the inductance of Reactors 3, 3a, 3b, and 3c is made into L/3 in this case, the inductance value of a discharge path becomes low and a current value continues rising with big current rate of change. This actuation is continued until system deviation IN1 becomes smaller than judgment level +dV of the system deviation judging machine 11.

[0031] When system deviation IN1 becomes smaller than judgment level +dV of the system deviation judging machine 11, system deviation IN1 falls within the range of judgment level**dV of the system deviation judging machine 11, and, in the output signal from an output terminal OUT1, H level (g) and the output signal from an output terminal OUT2 serve as L level (f). At this time, a logical circuit 12 tells each output signal of Comparators 17a, 17b, and 17c to switching circuit 2a, 2b, and each ON / off control terminal of 2c as it is (((c) d) e).

[0032] System deviation IN1 is also given to a controller 13, and a controller 13 gives the output signal set up so that it may become so small that the given system deviation IN1 is large to each inversed input terminal of Comparators 17a, 17b, and 17c. Comparators 17a, 17b, and 17c compare the size of the output signal of the given controller 13, and the saw tooth wave which has the positive/negative amplitude which was given from a saw tooth generator 14 or the phase conversion circuits 15 and 16, and from which 120 degrees of phases differ mutually, and give the output signal according to the comparison result to OR circuits 12d, 12e, and 12f.

[0033] As shown in (a), when the current command value which the current command generator 7 outputted changes from the high current value I2 to the small current value I1, the minimum value becomes - (I2-I1), and system deviation IN1 is the judgment level of the system deviation judging machine 11. - It is less than dV (b). In the output signal from the output terminal OUT1 of the system deviation judging machine 11, L level (g) and the output signal from an output terminal OUT2 serve as L level then (f).

[0034] At this time, with regards to the output signal of Comparators 17a, 17b, and 17c, there is nothing, each output of a logical circuit 12 serves as L level, and all of switching circuit 2a, 2b, and 2c become off. For the reason, it sets at all the paths of reactors 3c and 3, a lamp 4, and diode 5c in the path of the path of reactors 3a and 3, a lamp 4, and diode 5a, reactors 3b and 3, a lamp 4, and diode 5b, and a list. Since the current which flows to Reactors 3, 3a, 3b, and 3c decreases, induced electromotive force arises in Reactors 3, 3a, 3b, and 3c in the direction which negates the reduction, and a reflux current flows to the forward direction of Diodes 5a, 5b, and 5c temporarily.

[0035] Since the inductance of 4L/9 will connect too hastily with a lamp 4 equivalent when the inductance of Reactors 3, 3a, 3b, and 3c is made into L/3 in this case, the inductance value of the path of a reflux current becomes low, and a current value continues decreasing with big current rate of change. For this actuation, system deviation IN1 is the judgment level of the system deviation judging machine 11. - It continues until it becomes larger than dV.

[0036] System deviation IN1 is the judgment level of the system deviation judging machine 11. - When it becomes larger than dV, system deviation IN1 falls within the range of judgment level**dV of the system deviation judging machine 11, H level (g) and the output signal from an output terminal OUT2 serve as L level, and, as for the output signal from an output terminal OUT1, (f) and the system deviation IN1 mentioned above shift to the current control when falling within the range of judgment level**dV.

[0037] When the current command value which the current command generator 7 outputted is especially small, each switching circuit 2a, 2b, and the ON time amount of 2c become very short, and it becomes impossible to disregard the error and response delay of an output signal of a controller 13 based on system deviation IN1. Although each switching circuit 2a, 2b, and the ON time amount of 2c become longer than the ON time amount

which should be controlled for this reason and it is easy to become the unstable control of the current which flows on a lamp 4 exceeding a current command value greatly etc., in the power circuit of the gestalt of this operation, such a thing can be prevented beforehand.

[0038] Drawing 5 is a timing chart which shows such actuation. Each switching circuit 2a, 2b, the ON time amount (b) of 2c, (c), and (d) are controllable by the small ripple as shown in (a). Moreover, by the logic in the logical circuit 12 by the output signal (h) from the output terminal OUT1 of the system deviation judging machine 11, the output signal (i) from an output terminal OUT2 and the output signal (e) of Comparators 17a, 17b, and 17c, (f), and (g), since the repeat period can also be made small, switching loss can also be made small.

[0039] When according to the power circuit of the gestalt of this operation the inductance value on an equal circuit can be lowered only at the time of the standup of the current which flows on a lamp, and falling and a current command value changes with the above in the shape of a step at it, the change can be followed at a high speed and build up time and falling time amount can be shortened. Moreover, when a current command value is constant value, it cannot be concerned with the size but the amount of ripple can control the small stable current value in a wide range current value.

[0040] Gestalt 2. drawing 6 of operation is the block diagram showing the configuration of the gestalt of operation of the power circuit concerning the 1st, 3, and 4 invention. The parallel circuit where this power circuit consists of the series circuit of switching circuit 2a and reactor 3a, a series circuit of switching circuit 2b and reactor 3b, and a series circuit of switching circuit 2c and reactor 3c is connected between the forward side edge child of a capacitor 1, and one terminal of a reactor 3. The other-end child of a reactor 3 is connected to one terminal of the lamp 4 which is a load, and the other-end child of a lamp 4 is connected to the negative side terminal of a capacitor 1 through the current detector 6 which detects the current which flows on a lamp 4.

[0041] The cathode of free wheel diode 5a is connected at the node of switching circuit 2a and reactor 3a, and the anode is connected to the negative side terminal of a capacitor 1. The cathode of free wheel diode 5b is connected at the node of switching circuit 2b and reactor 3b, and the anode is connected to the negative side terminal of a capacitor 1. The cathode of free wheel diode 5c is connected at the node of switching circuit 2c and reactor 3c, and the anode is connected to the negative side terminal of a capacitor 1.

[0042] The current value which the current detector 6 detected is given to deflection computing-element 7a, and deflection computing-element 7a calculates the deflection (system deviation) of the current value which the current detector 6 detected, and the current command value given from the current command generator 7, and gives the calculated system deviation to the integration operator machine 18 and the proportionality computing element 19. The output signal IN2 of the proportionality computing element 19 is added by adder 7b with the output signal of the integration operator machine 18, and is given to one terminal of a switching circuit 23 while it is given to the gain (control) judging machine 20 (judgment means). The output signal of the control gain judging machine 20 is given to each ON / off control terminal of the switching circuits 21 and 22 (the 1st set point output means, the 2nd set point output means) connected to each output terminal of the signal generators 25 and 26 (the 1st set point output means, the 2nd set point output means) with which the terminal of one way each outputs the predetermined control signals V1 and V2 set up beforehand, respectively, and a switching circuit 23.

[0043] Each other-end child of switching circuits 21, 22, and 23 is connected to each inversed input terminal of Comparators 17a, 17b, and 17c, and the saw-tooth-wave signal which the saw tooth generator 14 (triangular wave signal output machine) generated is given to the non-inversed input terminal of comparator 17c. The saw-tooth-wave signal delayed from the saw-tooth-wave signal which the saw tooth generator 14 generated by the phase conversion circuit 15 120 degrees is given to the non-inversed input terminal of comparator 17b, and the saw-tooth-wave signal with which the phase conversion circuit 16 (triangular wave signal output machine) delayed 120 more degrees of saw-tooth-wave signals which the phase conversion circuit 15 (triangular wave signal output machine) delayed 120 degrees is given to the non-inversed input terminal of comparator 17a. The output terminal of Comparators 17a, 17b, and 17c is connected to the input terminal of another side of AND circuits 12c, 12b, and 12a, respectively, and AND circuits 12c and 12b and 12a output terminal are connected to switching circuit 2a, 2b, and ON / off control terminal of 2c, respectively.

[0044] Below, it explains, referring to the timing chart of drawing 7 which shows it for actuation of such a power circuit of a configuration. If the output signal IN2 of the proportionality computing element 19 exceeds

VMAX which is the upper limit judging level as shown in (c), the control gain judging machine 20 will close only a switching circuit 21, and will choose a control signal V1 as an input signal to each inversed input terminal of Comparators 17a, 17b, and 17c. If the control signal V1 is set up more greatly than the maximum output value of a saw tooth generator 14, the output signal of (b) and Comparators 17a, 17b, and 17c will serve as L level, and all of switching circuit 2a, 2b, and 2c will become off. Thereby, control action when a current command value falls in the shape of a step is performed (a).

[0045] If the output signal IN2 of the proportionality computing element 19 is less than VMIN which is the minimum judging level as shown in (c), the control gain judging machine 20 will close only a switching circuit 22, and will choose a control signal V2 as an input signal to each inversed input terminal of Comparators 17a, 17b, and 17c. If the control signal V2 is set up smaller than the minimum output value of a saw tooth generator 14, the output signal of (b) and Comparators 17a, 17b, and 17c will serve as H level, and all of switching circuit 2a, 2b, and 2c will become ON. Thereby, control action when a current command value starts in the shape of a step is performed (a).

[0046] When it is within the limits of the upper limit judging level VMAX and the minimum judging level VMIN, the output signal IN2 of the proportionality computing element 19 the control gain judging machine 20 (c), Only a switching circuit 23 is closed. As an input signal to each inversed input terminal of Comparators 17a, 17b, and 17c Control when a current command value is fixed is performed by the control signal adjusted so that the signal with which the output signal IN2 of the proportionality computing element 19 and the output signal of the integration operator machine 18 were added might be chosen and (b) and stable feedback control could be performed (a).

[0047] Moreover, even when it is large, (c), switching circuit 2a, 2b, and the ON time amount of 2c are very short and the output signal IN2 of the proportionality computing element 19 tends to produce an error small [the current command value given from the current command generator 7], by setting the upper limit judging level VMAX as the suitable value, the control gain judging machine 20 is stabilized and can perform the switching action of a switching circuit 21. Therefore, switching circuit 2a, 2b, and very short ON time amount of 2c can be controlled with a sufficient precision, and it can prevent passing a big ripple current unnecessary for a lamp 4.

[0048] When according to the power circuit of the gestalt of this operation the inductance value on an equal circuit can be lowered only at the time of the standup of the current which flows on a lamp, and falling and a current command value changes with the above in the shape of a step at it, the change can be followed at a high speed and build up time and falling time amount can be shortened. Moreover, when a current command value is constant value, it cannot be concerned with the size but the amount of ripple can control the small stable current value in a wide range current value.

[0049]

[Effect of the Invention] In the power circuit concerning the 1st invention, two or more series circuits which consist of the switching circuit and rear KUKUTORU which should make a loop-formation circuit including DC power supply or a capacitor, and a load are mutually connected to juxtaposition, and two or more free wheel diodes are connected to juxtaposition at a load and rear KUKUTORU, respectively. A current detector detects the current which flows for a load, and a deflection computing element calculates the deflection of the given control-command value and the current value which the current detector detected. Based on the deflection which the deflection computing element calculated, ON / off control means turns on/controls [off] a switching circuit, and controls [ON-] or controls [off-] a switching circuit instantaneous. The standup and falling of the output current which change in the shape of a step become quick by this, and the ripple of the output current becomes small.

[0050] In the power circuit concerning the 2nd invention, when it judges with said deflection having a judgment means within the limits of predetermined, according to the deflection, ON / off control means is the same periods from which a phase differs mutually, and turns on/controls [off] a switching circuit. When it judges with ON / off control means having a judgment means out of range [said deflection / predetermined], a switching circuit is ON-controlled or off controlled instantaneous. The standup and falling of the output current which change in the shape of a step become quick by this, and the ripple of the output current becomes small.

[0051] ON / off control means integrates the power circuit concerning the 3rd invention with the deflection which the deflection computing element calculated [the integration operator machine], and a proportionality

computing element carries out the multiplication of the predetermined gain to said deflection in it. The integral signal with which the integration operator machine integrated, and a proportionality computing element add the multiplication signal which carried out multiplication, and output an adder as a control signal. A comparator compares the signal which the triangular wave signal output machine outputted with the control signal which said adder outputted, and turns on/controls [off] a switching circuit according to the comparison result of a comparator. The standup and falling of the output current which change in the shape of a step become quick by this, and the ripple of the output current becomes small.

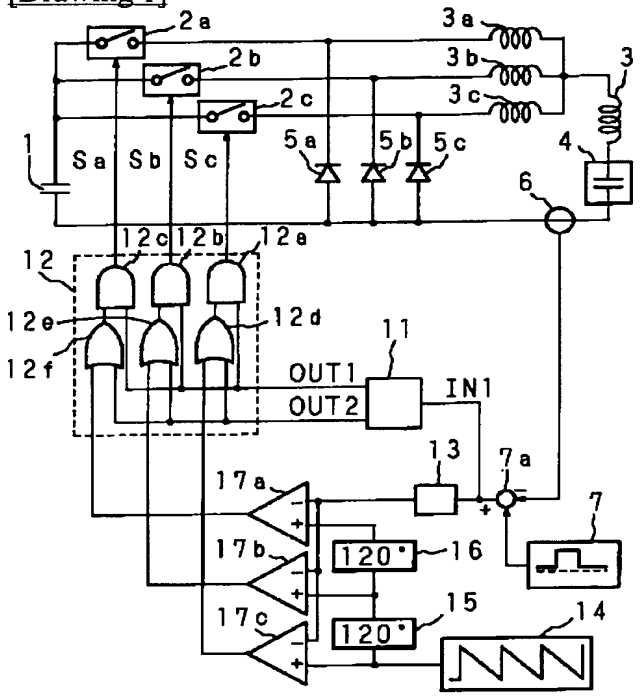
[0052] In the power circuit concerning the 4th invention, when the size of the multiplication signal with which the proportionality computing element carried out [the judgment means] the multiplication of ON / the off control means is judged and it judges with a multiplication signal having a judgment means larger than the 1st predetermined value, the 1st set point output means outputs the 1st set point set up beforehand as a control signal. When a judgment means judges with a multiplication signal being smaller than the 2nd predetermined value smaller than the 1st predetermined value, the 2nd set point output means outputs the 2nd set point set up beforehand as a control signal. A comparator compares the signal which the triangular wave signal output machine outputted with the control signal which the 1st or 2nd set point output means outputted, and turns on/controls [off] a switching circuit according to the comparison result of a comparator. The standup and falling of the output current which change in the shape of a step become quick by this, and the ripple of the output current becomes small.

[Translation done.]

* NOTICES *

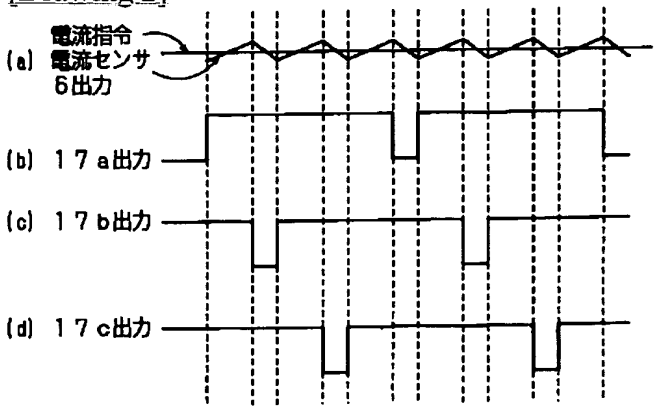
DRAWINGS

[Drawing 1]

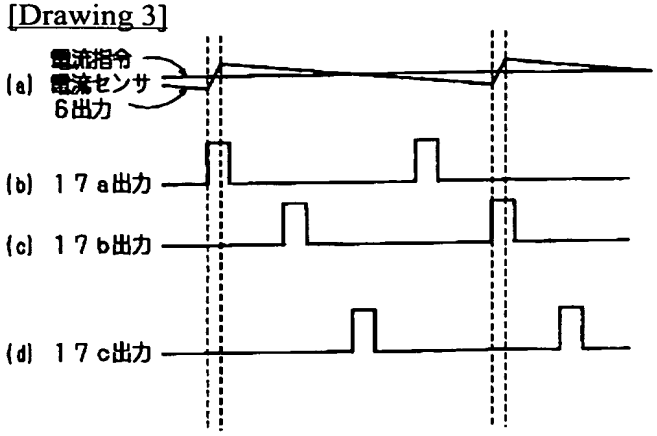


1：コンデンサ
2a～2c：スイッチ回路
3，3a～3c：リアクトル
7a：偏差演算器
11：レベル判定器
14：鋸歯状波発生器
20：ゲイン判定器

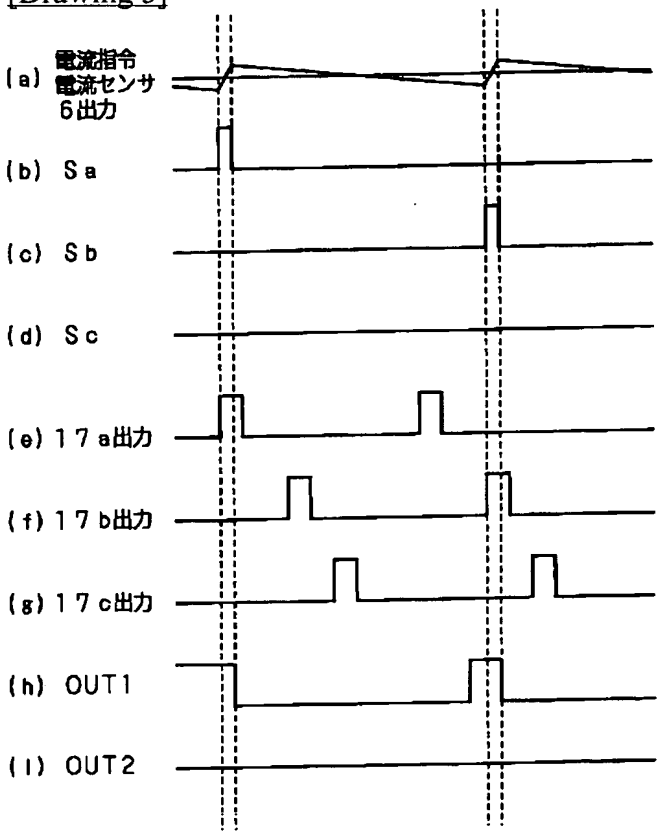
[Drawing 2]



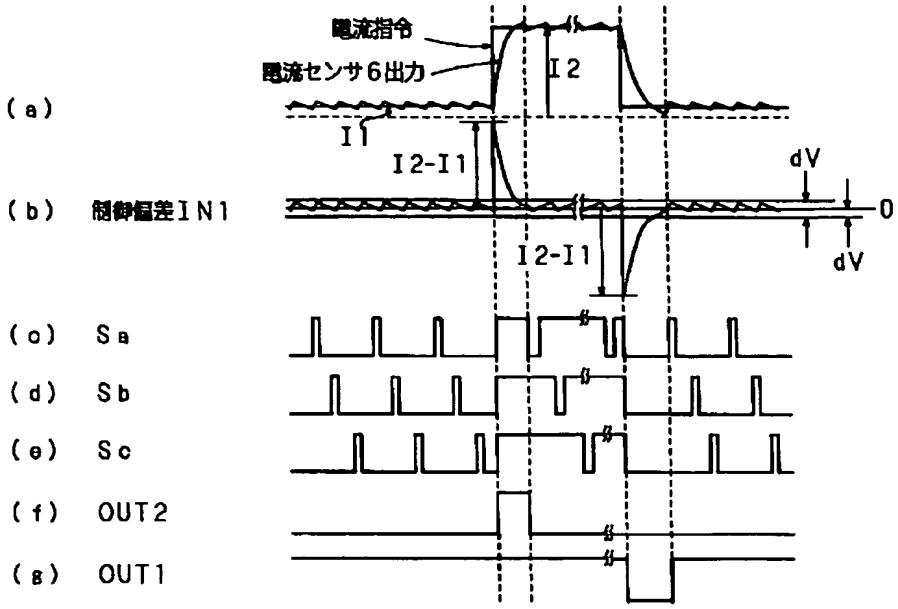
[Drawing 3]



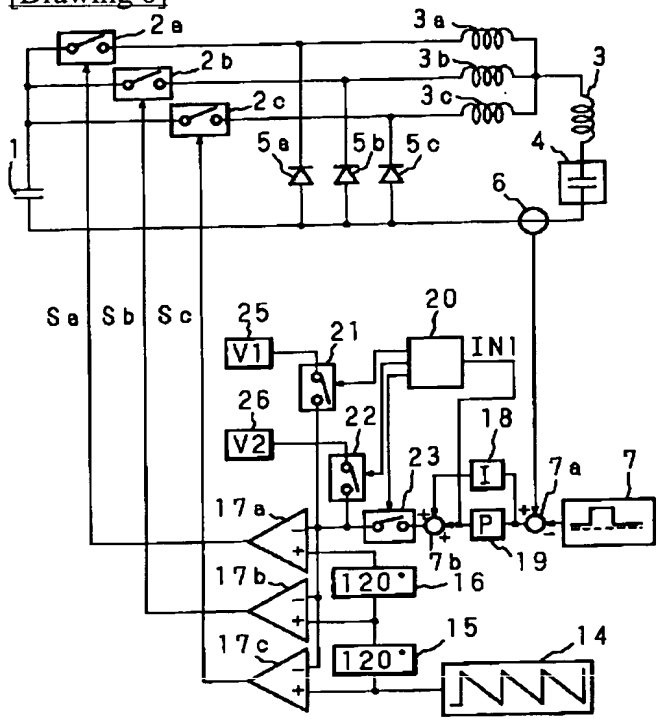
[Drawing 5]



[Drawing 4]

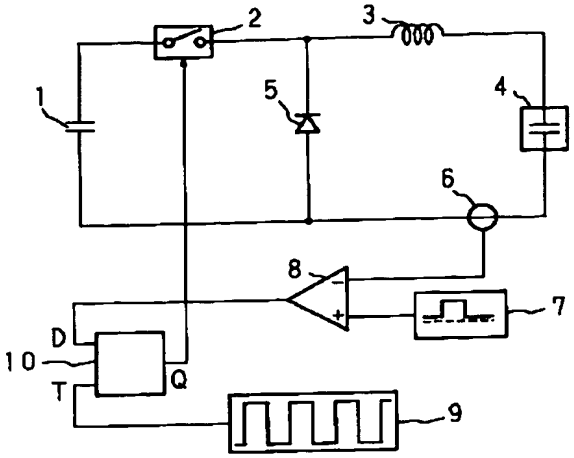


[Drawing 6]

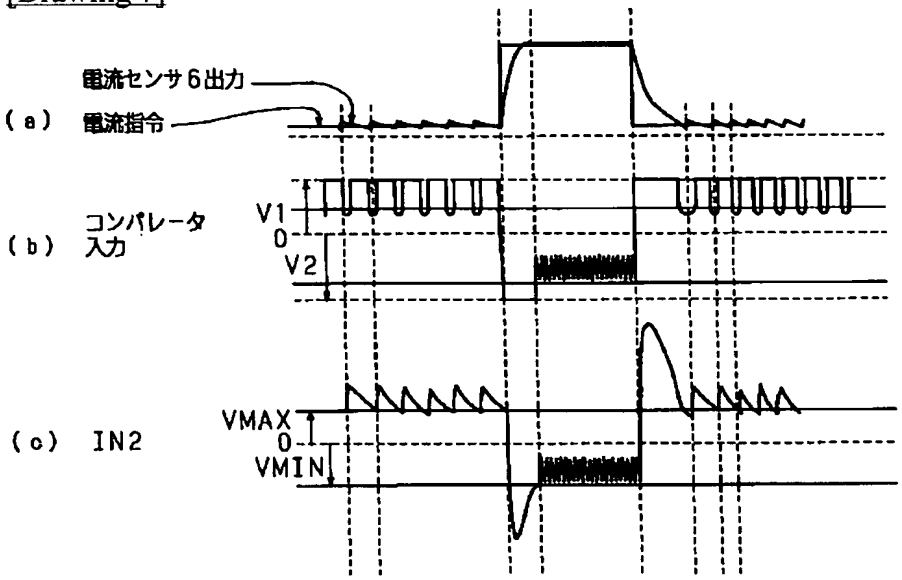


7b：加算器
20：ゲイン判定器
21~23：スイッチ回路
25，26：信号発生器
14：鋸波発生器
18：積分演算器
19：比例演算器

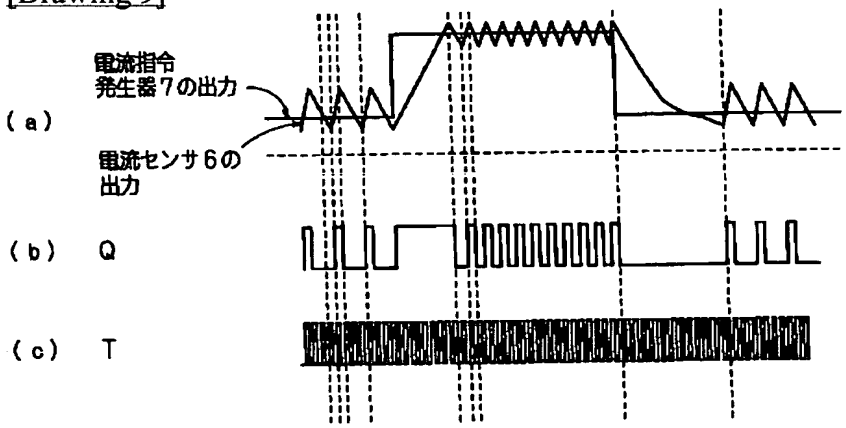
[Drawing 8]



[Drawing 7]



[Drawing 9]



[Translation done.]